(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
17 October 2002 (17.10.2002)

PCT

(10) International Publication Number
WO 02/081297 A2

(51) International Patent Classification[7]: B63B 9/06, 3/04, 25/16

(21) International Application Number: PCT/US02/10173

(22) International Filing Date: 2 April 2002 (02.04.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/280,745 3 April 2001 (03.04.2001) US

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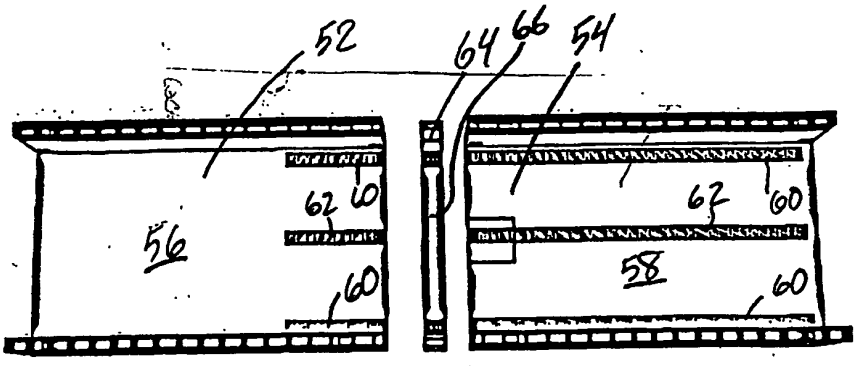
(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *without international search report and to be republished upon receipt of that report*

[Continued on next page]

(54) Title: LNG STORAGE VESSEL AND METHOD FOR CONSTRUCTING SAME



(57) Abstract: A module assembly floating dry-dock includes a first pontoon, a module turning caisson and a second pontoon positioned adjacent each other, each capable of independent lowering and raising. Hull module subassemblies are lifted into position onto the first pontoon and welded together to construct a hull module laying on its side. The first pontoon can be lowered to float the hull module such that the hull module can straddle the module turning caisson. The module turning caisson is then raised to engage a tilting roller conveyor with the hull module, and the first pontoon further lowered, to turn the hull module into an upright position. The hull module can be moved over the roller tracks to an assembly position on the second pontoon. The process is then repeated to construct a second hull module and move it into an aligned position adjacent the first hull module so that the two hull modules can be welded together.

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For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

LNG Storage Vessel And Method For Constructing Same

This application claims priority from U.S. Provisional Patent Application, 60/280,745, LNG Storage Vessel, filed April 3, 2001, the contents of which are incorporated by reference herein.

Field Of The Invention

The present invention relates to a floating LNG (Liquefied Natural Gas) storage vessel having a modular construction and a method of constructing same.

Background Of The Invention

LNG is often transported from port to port by large ocean-going tankers. However, the tankers are unable to dock in many ports due to their immense size, as well as due to various environmental restrictions on transferring LNG from a ship to land and vice-versa. There is a need for an LNG storage vessel that is smaller than an LNG tanker than can operate as a transfer vessel to transfer LNG between a shore facility and an LNG tanker. The cost for building such a vessel should be significantly below the cost for building using known technologies.

The present assignee of the invention has previously developed ship hull designs and construction methods which are disclosed in the following U.S. Patents, all of which are incorporated by reference herein: 5,085,161, Vessel Hull and Construction Method; 5,086,723, Double-hulled Vessel Construction Having Vertical Double-Walled Longitudinal Bulkhead; 5,090,351, Vessel Hull Construction and Method; 5,269,246, Vessel Hull Construction and Method; 5,293,830, Double-walled Vessel Hull Construction Utilizing T-

shaped subcomponents; 5,313,903, Method and Apparatus for Fabricating Double-walled Vessel Hull Midbody Modules; 5,320,055, Double-layered Vessel Wall Construction with Longitudinally Staggered Cell-to-Cell Access Openings Through Wall Layer-connecting Plates; and 5,577,454, Tank Vessel Subassembly for Equipment, Piping and other Nonstructural Components. The present assignee of the invention has also developed a new ship docking and coating facility that can be utilized in fabricating, moving and repositioning the modules of the LNG storage vessel. This ship docking and coating facility is disclosed in U.S. Patent Application 60/270,877, Environmentally Enclosed Ship Coating Depot, filed February 26, 2001, which is also incorporated by reference herein.

Brief Summary Of The Invention

The present invention is a floating LNG storage vessel having a modular construction and a method of constructing same. A module assembly floating dry-dock includes a first pontoon, a module turning caisson and a second pontoon positioned adjacent each other, each capable of independent lowering and raising by ballasting and deballasting internal tanks. Hull module subassemblies are constructed on a subassembly construction fixture and then lifted into position onto the first pontoon where they are aligned with respect to one another and welded together to construct a hull module laying on its side.

The first pontoon can be lowered to float the hull module such that the hull module can be moved to a position straddling the module turning caisson. The module turning caisson is then raised to engage a tilting roller conveyor with the hull module, and the first pontoon further lowered, to turn the hull module into an upright position over a set of roller tracks mounted on the module assembly floating dry-dock. Once the hull module has been turned into the upright position, the first pontoon is raised and the module turning caisson is

lowered to align decks of the pontoons and the module turning caisson so that the hull module can be moved over the roller tracks to an assembly position on the second pontoon. The process is then repeated to construct a second hull module and move it into an aligned position adjacent the first hull module so that the two hull modules can be welded together.

The first pontoon can then be lowered, an LNG tank previously insulated above its waterline can be floated onto the first pontoon and the first pontoon raised. Load bearing insulation can be installed on a lower portion of the attached hull modules and a height adjustable rail system can be installed on an interior roof of the hull modules. A plurality of rail roller guides are also correspondingly installed on a top of a framework of the LNG tank. The first pontoon and module turning caisson are then raised and the second pontoon lowered to align the rail roller guides with the rails. The LNG tank is then moved toward the hull modules to engage the rail roller guides with the rails to support the LNG tank as it is moved into the hull modules. Once the LNG tank is fully moved into the hull modules, construction of a third hull module can begin on the first pontoon. In this manner, the tank is positioned in the hull modules without the need of cranes.

The third hull module can then be moved and turned as with the first two hull modules to be positioned adjacent the first two hull modules in an upright position. Support structure and insulation is added to the third module and the third module moved into an aligned contact with the other hull modules so that they can be welded together. Once this is done, the LNG tank can be lowered by the screw jacks onto the load-bearing insulation. This tank module can be completed by adding desired outfitting and equipment. The process can be repeated to add additional tank modules to the first until a desired size of LNG storage vessel has been completed.

The present invention can also be used to construct in a modular fashion other types of vessels, with or without tanks, for transporting or storing other types of goods and materials.

It is an object of the present invention to provide an apparatus and method for turning constructed hull modules upright without need of a crane.

It is a further object of the present invention to provide an apparatus and method for moving and positioning multiple hull modules so that they can be welded together in an aligned manner.

It is a further object of the present invention to provide an apparatus and method for installing a large, heavy tank in a hull structure without need of a crane.

It is a further object of the present invention to provide a method for constructing a modular water going vessel.

It is a further object of the present invention to construct a tank containing vessel where the tank has been insulated above a waterline to allow water movement of the tank prior to installation in a hull structure and insulation for below the tank waterline is installed in the hull structure prior to installation of the tank in the hull structure.

These and other objects, details and advantages of the present invention will be apparent from the following detailed description of a preferred embodiment, when read in conjunction with the accompanying drawings.

Brief Description Of The Drawings

Fig. 1 is a perspective view of an LNG tank positioned in a dry-dock;

Fig. 2 is a perspective view of the tank of Fig. 1 with an external framework installed;

Fig. 3 is a perspective view of three tanks of Fig. 2 positioned in the dry-dock;

Fig. 4 is a perspective view of the three tanks of Fig. 3 rolled onto their sides;

Fig. 5 is a perspective view of the three tanks of Fig. 4 positioned adjacent a transport ship;

Fig. 6 is a perspective view of the three tanks of Fig. 6 rolled back onto their bottoms and positioned over the lowered transport ship;

Fig. 7 is a perspective view of the three tanks of Fig. 6 unloaded from the transport ship into an insulation installation dry-dock;

Fig 8 is a perspective view of an LNG storage vessel construction facility of the present invention;

Fig. 9 is a perspective view of a subassembly construction fixture of the LNG storage vessel construction facility of Fig. 8;

Figs. 10 and 11 are perspective views of the LNG storage vessel construction facility of Fig. 8 showing a hull module subassembly being moved from the subassembly construction fixture to a first pontoon of a module assembly floating dry-dock;

Fig. 12 is a perspective view of the module assembly floating dry-dock showing a plurality of hull module subassemblies connected together;

Fig. 13 is a perspective view of the module assembly floating dry-dock showing a completed hull module;

Fig. 14 is a perspective view of the module assembly floating dry-dock showing the completed hull module of Fig. 13 with stabilizing runners attached;

Fig. 15 is a perspective view of a module assembly floating dry-dock of the present invention;

Fig. 16 is a perspective view of a module turning caisson and second pontoon of the module assembly floating dry-dock of Fig. 15;

Fig. 17 is a perspective detail view of a module turning caisson of Fig. 16 showing a tilting roller conveyor in a lowered position;

Fig. 18 is a perspective detail view of the tilting roller conveyor of Fig. 17 in a raised position;

Fig. 19 is a perspective detail view of the tilting roller conveyor of Fig. 17 in a raised position engaging a hull module;

Fig. 20 is a cut-away perspective view of the module assembly floating dry-dock of Fig. 15 with a hull module positioned thereon;

Fig.21 is a cut-away perspective view of the module assembly floating dry-dock of Fig. 20 showing movement of the hull module positioned thereon;

Fig.22 is a cut-away perspective view of the module assembly floating dry-dock of Fig. 21 showing movement of the hull module positioned thereon;

Fig.23 is a cut-away perspective view of the module assembly floating dry-dock of Fig. 22 showing movement of the hull module positioned thereon;

Fig. 24 is a cut-away perspective detail view of the module assembly floating dry-dock of Fig. 23;

Fig.25 is a cut-away perspective view of the module assembly floating dry-dock of Fig. 23 showing movement of the hull module positioned thereon;

Fig.26 is a perspective view of the module assembly floating dry-dock of Fig. 25 showing movement of the hull module positioned thereon;

Fig.27 is a perspective view of the module assembly floating dry-dock of Fig. 26 showing two hull modules positioned thereon;

Fig.28 is a perspective view of the module assembly floating dry-dock of Fig. 27 showing two hull modules and an LNG tank positioned thereon;

Fig.29 is a detail perspective view of the module assembly floating dry-dock of Fig. 27 showing the attachment of rail and roller guide assemblies to the two hull modules and LNG tank;

Fig. 30 is an elevational view of a rail and screw jack assembly of Fig. 29;

Fig.31 is a cut-away perspective view of the module assembly floating dry-dock of Fig. 28 showing movement of the LNG tank positioned thereon;

Fig.32 is a cut-away perspective view of the module assembly floating dry-dock of Fig. 31 showing movement of the LNG tank positioned thereon;

Fig. 33 is a detail perspective view of the module assembly floating dry-dock of Fig. 32 showing engagement of the LNG tank with hull modules;

Fig. 34 is a perspective view of the module assembly floating dry-dock of Fig. 33 showing full engagement of the LNG tank with hull modules;

Fig. 35 is a perspective view of the module assembly floating dry-dock of Fig. 34 showing movement of a third hull module;

Fig. 36 is a perspective view of the module assembly floating dry-dock of Fig. 35 showing movement of the third hull module;

Fig. 37 is a detail perspective view of the module assembly floating dry-dock of Fig. 36 showing attachment of support structure to a bulkhead of the third hull module;

Fig. 38 is a detail perspective view of the module assembly floating dry-dock of Fig. 37 showing attachment of insulation to the third hull module;

Fig. 39 is a perspective view of the module assembly floating dry-dock of Fig. 38 showing movement of the third hull module; and

Fig. 40 is a perspective view of a completed vessel module according to the present invention.

Detailed Description Of The Preferred Embodiments

Fig. 1 is a perspective view of an LNG tank 10 positioned in a dry-dock 12 used for building the tank. The tank 10 is of a conventional generally symmetrical construction and has maximum dimensions of 85 feet wide by 164 feet, 2 inches long by 74 feet, 2 inches high. This size is important as it is the largest size that can travel through the St. Lawrence Seaway from the tank building dry-dock 12 to an LNG storage vessel manufacturing facility described below. In the preferred embodiment, the tanks 10 are of a known triple plate welded, nickel alloy construction. Although not shown, the dry-dock 12 can be enclosed by a building or a temporary construction to enclose the dry-dock 12 against the atmosphere and allow more comfortable year-round work on constructing tanks 10. Once the basic LNG tank 10 is constructed, an encompassing exterior framework 14 is constructed around the tank 10, except for bottom portions of the tank 10. This framework 14 is generally constructed of steel and helps maintain the constructed shape of the tank 10, as well as allow relatively easy attachment of other structures to the tank 10 without damage to the tank 10. See Fig. 2.

Once the tank 10 has been completed, it can be floated, it can be transferred to the LNG storage vessel construction facility. In the preferred embodiment, three tanks 10 are moved together, as three tanks can be accommodated on available transport ships. See Fig. 3,

which shows three completed tanks 10 ready for transfer. To pass through the St. Lawrence Seaway, the tanks 10 must first be rolled onto their sides by known methods of ballasting certain portions of the tanks and then using cranes to roll the tanks 10. This minimizes the width of the tanks 10 for passage through the St. Lawrence Seaway. See Fig. 4, which shows the three tanks 10 floating on their sides in the dry dock 12 with the uncovered bottom portions 16 of the tanks 10 to the left.

The tanks 10 are then moved by a tugboat to a waiting transport ship 18. See Fig. 5. There, they are rolled upright by the same methods as previously used and moved into position over the lowered transport ship 18. See Fig. 6. The tanks 10 are then transported by the transport ship 18 to another dry-dock facility 20 located at or near the LNG storage vessel construction facility, removed from the transport ship 18 and placed in the dry-dock facility 20 for installation of insulation on the tanks 10. See Fig. 7, which shows the three tanks 10 positioned in the second dry-dock facility 20. In an alternative embodiment, the construction and insulation of the tanks 10 can be performed in the same facility, as long as the tanks are not required to be rolled to pass through a waterway, since the insulation commonly used to insulate the tanks 10 cannot be immersed in water.

The tanks 10 can then be insulated. Since only approximately 2 or 3 cranes in the world could lift the finished tanks 10, the tanks 10 must still be floated to the LNG storage vessel construction facility once insulated. Therefore, insulation is only applied to just above the waterlines of the tanks 10. The insulation is a compressed board material and is installed between the framework 14 so that the outer portions of the framework remain exposed.

The LNG storage vessel construction facility 30 includes a dock based subassembly construction fixture 32 and a module assembly floating dry-dock 50 which includes a first pontoon 52 and a second pontoon 54. See Fig. 8. The subassembly construction fixture 32 is described in the references identified in the Background section hereof and is used to build

double hulled subassemblies 34 used for constructing a hull module 40. See Fig. 9. Once each subassembly 34 is finished, it is raised by floating crane 36 (see Fig. 10) and lowered into a desired position on the first pontoon 52 of the module assembly floating dry-dock 50 (see Fig. 11). Another subassembly 34 is constructed in the subassembly construction fixture 32 and then similarly moved by the crane 36 into position adjacent the first subassembly 34. The two subassemblies are then welded together and the process repeated until a hull module 40 is completed. See Figs. 12 and 13. This construction of the hull modules 40 will preferably take place simultaneously with the construction, transport and insulation of the tanks 10 to reduce overall construction time for each LNG storage vessel.

Once the hull module 40 is completely assembled and welded together, stabilizing runners 42 are attached to each outer bottom edge portion 44 of the hull module 40.The stabilizing runners 42 include a number of braces 46 shaped to conform to an outer surface of the hull module and an outer support plate 48 welded to the braces 46 to tie them together. Preferably, the stabilizing runners 42 are welded to the hull module 40. The stabilizing runners 42 provide two functions. First, they provide bottom support to the hull module 40 once the hull module 40 has been turned so that its bottom surface is positioned against the first pontoon 52. This will be described in more detail below. Second, the stabilizing runners 42, with the support plates 48, provide a mechanism by which to align the hull module 40 on the module assembly floating dry-dock 50, as well as to align two hull modules 40 with respect to one another so that they may be welded together properly in a straight, aligned manner. Once the hull modules 40 have been welded to each other in the desired aligned manner, the stabilizing runners 42 can be removed from the hull modules 42.

The module assembly floating dry-dock 50 includes the first pontoon 52 and the second pontoon 54. See Fig. 15. Each of these pontoons are of a known type and can be lowered and raised by ballasting and deballasting internal tanks to submerge and uncover

decks 56 and 58 thereof. Two outer roller tracks 60 and a center roller track 62 are positioned on the decks 56 and 58. See also Fig. 16. These roller tracks 60 and 62 are of known configuration using a plurality of bearing mounted rollers to provide a low friction roller surface over which the hull modules 40 and tanks 10 can be moved. The module assembly floating dry-dock 50 also includes a module turning caisson 64. The module turning caisson 64 has the same basic configuration as the pontoons 52 and 54 but is much shorter in length and is preferably has a total height of 90 feet from a bottom of the hull to its wing walls, a height of 40 feet from the bottom of the hull to the deck 66 and has a total width of 230 feet from port to starboard side. It can be raised and lowered by ballasting and deballasting internal tanks and has a deck 66. Since, in the preferred embodiment, the module turning caisson 64 will be raised higher than the pontoons 52 and 54, it will have a deeper draft as compare to the pontoons 52 and 54 to provide the increased lifting height.

Two tilting roller conveyors 68 are attached to the deck 66. See Figs. 17 and 18. Each tilting roller conveyor can be pivotally attached to the deck 66 so that a free end 70 of the tilting roller conveyor 68 can be raised and lowered about the pivoting attachment 72. Each tilting roller conveyor 68 includes a plurality of bearing mounted rollers 74 and one or more pivoting holding flanges 76. The pivoting holding flanges 76 can be pivoted up to a raised position to engage a portion of a hull module 40, as will be described below, or pivoted downward to a lowered position to allow a hull module 40 or tank 10 to slide over the rollers 74 when the tilting roller conveyor 68 is pivoted to a lowered position. Each tilting roller conveyor 68 is translatable along the width of the deck by either providing additional pivoting attachments 72 or by mounting the pivoting attachments 72 on a rail mechanism mounted to deck 66. In this manner, the tilting roller conveyors can be adjusted to accommodate different widths of hull modules 40, when turning the hull modules as described below, but can then be returned to positions to align with the outer roller tracks 60

when a hull module 40 or tank 10 is being moved down the length of the module assembly floating dry-dock 50.

The pivoting holding flanges 76 of each tilting roller conveyor 68 are appropriately spaced apart and can be pivoted upward to each engage a transverse plate portion 80 of a hull module 40. See Fig. 19 (with a hull module 40 shown in phantom). This allows the hull module 40 to be gripped by the tilting roller conveyors 68 when the hull module 40 is being turned, as described below. Each tilting roller conveyor 68 can be raised and lowered by any known mechanism, including by crane and by hydraulic cylinder.

The process of turning a hull module will now be described. Fig. 20 shows the module assembly floating dry-dock 50 with a wing wall of the first pontoon 52 cut away to better see a position of a completed hull module 40 on deck 52. Each of the first pontoon 52, second pontoon 54 and module turning caisson 64 are in a raised position so that their respective decks are above water. Next, first pontoon 52 and module turning caisson 64 are lowered by ballasting internal tanks. See Fig. 21. Since hull module 40 includes transverse bulkheads in its longitudinal cells, it will float when submerged to a certain depth. Fig. 21 shows the hull module 40 floating and having been moved while floating, by winches or other known mechanisms, to a position over the tracks 60 and 62. The hull module 40 is further moved so that a first end of the hull module 40 nearest the second pontoon is positioned over the module turning caisson 64. See Fig. 22. It is preferred that the hull module 40 be positioned so that its center of gravity is offset toward the first pontoon, so that there is a natural tendency for the hull module 40 to turn in the desired direction.

The first pontoon 52 is then further lowered and the module turning caisson 64 raised to tilt the hull module 40. See Fig. 23. The buoyancy of the hull module 40 because of the closed cells described above supports a portion of the weight of the hull module 40 during this step of the process. As better seen in Fig. 24, the hull module 40 is engaged with the

tilting roller conveyors 68 and the pivoting holding flanges 76 engaged with the transverse plate portion 80 of the hull module 40 to prevent the hull module 40 from sliding off the module turning caisson 64 during this portion of the turning process. In the preferred embodiment, the tilting roller conveyors 68 are not used as jacks to raise the hull module 40 by actively pivoting the tilting roller conveyors 68 but rather passively tilt by engagement with the hull module 40 as the hull module 40 turns. Alternatively, the pivoting of the tilting roller conveyors can be made active with known mechanisms, such as hydraulic rams, to assist in turning the hull module 40.

As the turning proceeds, a bottom portion of the stabilizing runners 42 engage with the roller tracks 60 to allow the bottom of the hull module to roll along the tracks 60. The turning process continues by continuing to raise the module turning caisson 64 and/or lower the first pontoon 52 until the hull module is in an upright position. See Fig. 25. The first pontoon 52 is then raised and the module turning caisson 64 lowered so that the decks 56, 58 and 66 are even with one another above the waterline. See Fig. 26. The hull module can then be rolled along the roller tracks 60 and 62 (with the stabilizing runners 42 continuing to engage roller tracks 60) to move the hull module into an assembly position on the second pontoon 54. A second hull module 40 is then constructed on the first pontoon 52 and the turning and moving process repeated with respect to the second hull module 40 until the second hull module 40 has bee positioned in an aligned manner adjacent the first hull module 40 so that the two hull modules 40 can be welded together. See Fig. 27.

Once the two hull modules 40 have been welded together (at least on an interior thereof, load bearing insulation 82 can be installed in a lower portion of the combined hull modules 40 up to the height where the insulation on the tank 10 (described above) stops. Since the tank 10 will eventually sit directly on this insulation 82, it must be load bearing.

Such insulation can be a known load bearing insulation or can be a combined load bearing structure with interspersed insulation.

In the meantime, the first pontoon 52 can be lowered, a tank 10 floated onto the first pontoon 52 and the first pontoon 52 raised, so that the deck 56 is above the waterline. See Fig. 28. At this point, a plurality of removable load supporting rails 90 are installed on an interior roof of the assembled hull modules 40. See Fig. 29. These load supporting rails are attached to the hull modules 40 by a plurality of screw jacks 92 mounted through the hull of the hull modules 40. See Fig. 30. Each cell of the hull module is sufficiently large that a man can enter the cells to operate the screw jacks. Alternatively, the screw jacks 92 can extend beyond the upper outer hull of the hull modules 40 and be operated from the outside of the hull modules 40.

Correspondingly, a plurality of rail roller guides 94 are attached to the top of the framework 14 of tank 10, aligned so as to be able to engage and slide along the respective rails 90. These rail roller guides 94 can be installed while the tank 10 is on the first pontoon 54 or prior to that time, for instance, after the insulation has been installed on the tank but prior to the tank 10 leaving the second dry-dock. This rail system is used to align and support the tank 10 as it is being inserted into the hull modules 40. If the tank 10 is not raised above the insulation 82 before the tank is moved into the hull modules 40, the force required to move the tank 10 will be extremely high and damage can occur to the insulation 82 and/or tank 10 if the tank 10 is forced to slide across the insulation 82. Alternatively, the positioning of the rails and rail roller guides can be reversed.

Once the rails 90 and rail roller guides 94 have been installed, the first pontoon 52 and module turning caisson 64 can be lowered to float the tank 10 and the tank 10 moved into a position where it is overhanging the module turning caisson 64. See Fig. 31. The first pontoon 52 and module turning caisson 64 can then be raised, and the second pontoon 54

lowered somewhat but not so much as to immerse the load bearing insulation 82, until the rail roller guides 94 can be aligned with the respective rails 90. See Fig. 32. The tank 10 can then be moved using winches and cables to engage the rail roller guides 94 with the rails 90 so that the tank 10 can be moved into the interior of the hull modules 40 (see Fig. 33) until it is completely installed in the hull modules 40 (see Fig. 34). In this manner, the tank 10 has been completely installed into the hull modules 40 without the need for cranes.

The next hull module 40 can then be built on the first pontoon 52 and turned as with the first two hull modules 40. See Figs. 35 and 36. In this embodiment, the third hull module 40 has a bulkhead 41 installed on a side facing the tank 10 to close off the tank compartment and the first hull module 40 also has a bulkhead 41 to close off the other end of the tank compartment. Alternatively, the tank compartment can be closed on the open end by installing a separate bulkhead without also installing an additional hull module. This may be done at the completion of the LNG storage vessel to seal off the last open tank compartment. The bulkhead 41 on the third hull module can then be outfitted with the necessary support structure 96 (see Fig. 37) and load bearing insulation 82 installed (see Fig. 38). Support structure similar to support structure 96 was installed on the first and second hull modules 40 during their construction but could not be done on the third hull module 40 since the support structure 96 is installed on what had been a bottom surface of the hull module 40 during construction of that hull module 40.

Once the outfitting of the third hull module 40 is done, it can be moved into an aligned position adjacent the second hull module 40 and then welded to the second hull module 40. See Fig. 39.At this point, the rails 90 can be lowered with the screw jacks 92 to lower the tank 10 onto the load bearing insulation 82. The tank 10 can then be detached from the roof of the hull modules 40, if desired, by detaching and/or removing the rails 90, screw jacks 92 and/or rail roller guides 94. The components will not b needed again to raise the tank

and it is presently preferred that they be detached and./or removed so that the tank 10 is free to move due to thermal expansion and contraction of the tank 10 from the LNG. If the tank 10 remains firmly fixed to the roof of the hull modules 40, the thermal expansion and contraction of the tank 10 could damage the tank 10 and/or hull modules 40.

Superstructure, outfitting, processing, transfer and/or other equipment can be added to the hull modules 40 as required to finish each tank module 98. See Fig. 40. A plurality of such tank modules can be attached together to build an LNG storage vessel of larger size, limited primarily by the capacity of the module assembly floating dry-dock 50. Once the tank module has been made watertight, the second pontoon 54 can be lowered to float the tank module to either move the tank module along the length of the second pontoon 54 so that additional hull modules 40 can be added, or when complete, the vessel can be floated free from the module assembly dry-dock 50. In one embodiment, the vessel will be approximately 600 feet long by 190 foot beam and 100 foot depth.

In the manner described above, an LNG storage vessel can be built in a modular manner with a plurality of LNG storage tanks. Although, the present invention has been described with respect to the building of an LNG storage vessel, other types of vessels can be built in the same modular manner, with or without internal tanks 10, for transporting, processing and/or storing a variety of different goods and materials. In an alternative embodiment, the tanks 10 may be used for holding other types of materials and if not required for such materials, the insulation can be omitted.

It is intended that the present invention can be practiced in various combinations of the various aspects of the embodiments described above.

Claims:

1. A method for constructing a module for assembly into a vessel, comprising:

constructing a first floatable hull module in a side down position on a first floating pontoon;

partially lowering the first floating pontoon to float the hull module;

moving the floating hull module to a position where a first end of the hull module straddles a submerged module turning caisson positioned adjacent the first floating pontoon;

raising the module turning caisson to engage and raise the first end of the hull module;

lowering further the first floating pontoon to lower a second end of the hull module until the hull module is rotated into an upright position on the first floating pontoon.

2. A method as in claim 1, and further comprising:

lowering the module turning caisson;

moving the upright hull module into an assembly position on a second floating pontoon;

repeating the steps to create a second upright hull module and positioning the second hull module adjacent the first hull module;

connecting the first and second hull modules.

3. A method as in claim 2; and further comprising:

installing a plurality of rails on an inner roof of the connected first and second hull modules;

lowering the second pontoon to lower the connected first and second hull modules to a position for accepting a tank;

moving the tank into a position where a plurality of rail roller guides on an upper surface of the tank engage the plurality of rails; and

moving the engaged tank into the interior of the connected first and second hull modules on the rails so that a bottom of the tank is raised above and avoids contact with structure of the hull modules.

4. A method as in claim 3, wherein at least one holding flange of at least one tilting roller conveyor pivotally attached to the module turning caisson engages a transverse plate portion of the hull module to raise the first end of the hull module.

5. A method as in claim 4, wherein the upright hull modules are moved into the assembly position on the second pontoon on at least one set of roller tracks.

6. A method as in claim 1, wherein at least one holding flange of at least one tilting roller conveyor pivotally attached to the module turning caisson engages a transverse plate portion of the hull module to raise the first end of the hull module.

7. A method for installing a tank into a hull module assembly, comprising:

positioning the hull module assembly on a second pontoon of a module assembly floating dry-dock adjacent a module turning caisson side edge of the second pontoon;

lowering a first pontoon of the module assembly floating dry-dock;

floating the tank onto the first pontoon;

attaching a plurality of height adjustable rails on an interior roof of the hull module assembly;

attaching a plurality of rail guide rollers on a top of the tank, constructed and arranged to engage respective ones of the rails;

floating the tank over a module turning caisson positioned between the first pontoon and the second pontoon;

performing at least one of lowering the second pontoon and raising the module turning caisson to align the rail guide rollers with the rails;

moving the tank toward the hull module assembly to engage the rail guide rollers with the rails; and

moving the tank into the hull module assembly with a weight of the tank being at least partially supported by the rails and a bottom of the tank being raised above and avoiding substantive contact with structure of the hull module assembly.

8. A method as in claim 7, and further comprising:

lowering the rails once the tank is fully positioned in the hull module assembly to bring the bottom of the tank into load-bearing contact with the structure of the hull module assembly.

9. A method as in claim 8, and further comprising:

disengaging the at least one of the rails and the rail roller guides from the hull module assembly.

10. A module assembly floating dry dock, comprising:

a first pontoon having a first deck surface, the first pontoon capable of independently lowering and raising the first deck surface by ballasting and deballasting internal tanks;

a second pontoon having a second deck surface, the second pontoon capable of independently lowering and raising the second deck surface by ballasting and deballasting internal tanks;

a module turning caisson having a third deck surface, the module turning caisson capable of independently raising and lowering the third deck surface by ballasting and deballasting internal tanks, the module turning caisson positioned between the first pontoon and the second pontoon such that the three deck surfaces can be aligned with one another to form an extended deck surface;

wherein the module turning caisson is constructed and arranged to engage a first end of a hull module positioned over the module turning caisson and raise the first end of the hull module by raising the third deck surface and the first pontoon is constructed and arranged to be lowered to lower a second end of the hull module such that the hull module is turned to an upright position.

11. A module assembly floating dry dock as in claim 10, and further comprising:

at least one set of roller tracks positioned on the first deck surface constructed and arranged to engage the second end of the hull module when the module turning caisson is raised and the first pontoon is lowered to reduce friction between the hull module and the first pontoon and ease turning of the hull module to an upright position.

12. A module assembly floating dry dock as in claim 11, and further comprising:

at least one tilting roller conveyor pivotally attached to the module turning caisson, the tilting roller conveyor having at least one holding flange constructed and arranged to engage and grasp a transverse plate portion of the hull module to raise the hull module.

13. A module assembly floating dry dock as in claim 12, wherein the holding flange of the tilting roller conveyor is pivotable between a raised position to engage the hull module and a lowered position to allow the hull module to roll over the tilting roller conveyor.

14. A module assembly floating dry dock as in claim 10, and further comprising:

at least one tilting roller conveyor pivotally attached to the module turning caisson, the tilting roller conveyor having at least one holding flange constructed and arranged to engage and grasp a transverse plate portion of the hull module to raise the hull module.

15. A module assembly floating dry dock as in claim 14, wherein the holding flange of the tilting roller conveyor is pivotable between a raised position to engage the hull module and a lowered position to allow the hull module to roll over the tilting roller conveyor.

16. A method for insulating and installing a tank into a hull module assembly, comprising:

insulating a tank above a waterline at a first location;

floating the tank from the first location onto a first pontoon of a module assembly floating dry-dock

positioning the hull module assembly on a second pontoon of a module assembly floating dry-dock and insulating a lower portion of an interior of the hull module assembly corresponding to a portion of the tank below the waterline of the tank;

attaching a plurality of height adjustable rails on an interior roof of the hull module assembly;

attaching a plurality of rail guide rollers on a top of the tank, the rail guide rollers constructed and arranged to engage respective ones of the rails;

performing at least one of lowering the second pontoon and raising the first pontoon to align the rail guide rollers with the rails;

moving the tank toward the hull module assembly to engage the rail guide rollers with the rails; and

moving the tank into the hull module assembly with a weight of the tank being at least partially supported by the rails and a bottom of the tank being raised above the insulation of the hull module assembly to avoid substantive contact with the insulation.

17. A method as in claim 16, and further comprising:

lowering the rails once the tank is fully positioned in the hull module assembly to bring the bottom of the tank into load-bearing contact with the insulation of the hull module assembly.

18. A method as in claim 17, and further comprising:

disengaging at least one of the rails and the rail roller guides from the hull module assembly.

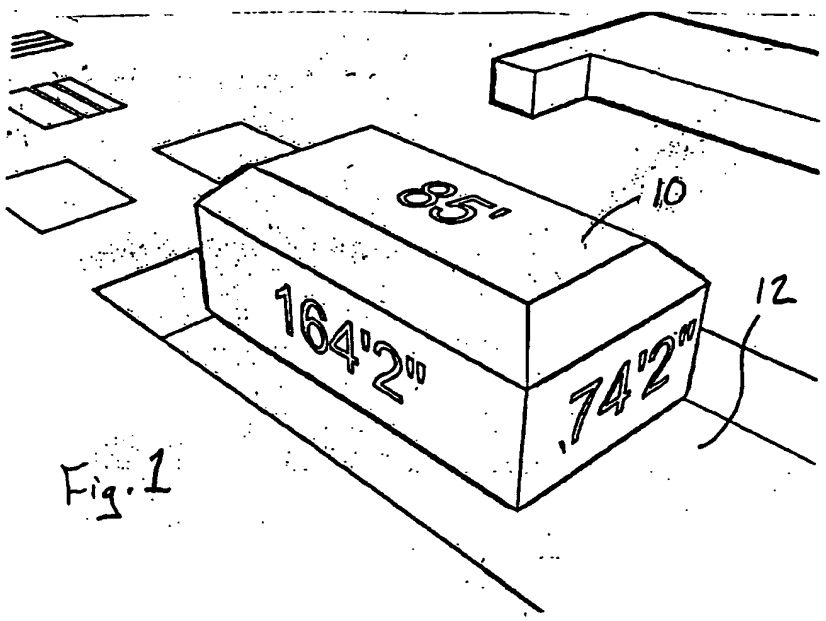


Fig. 1

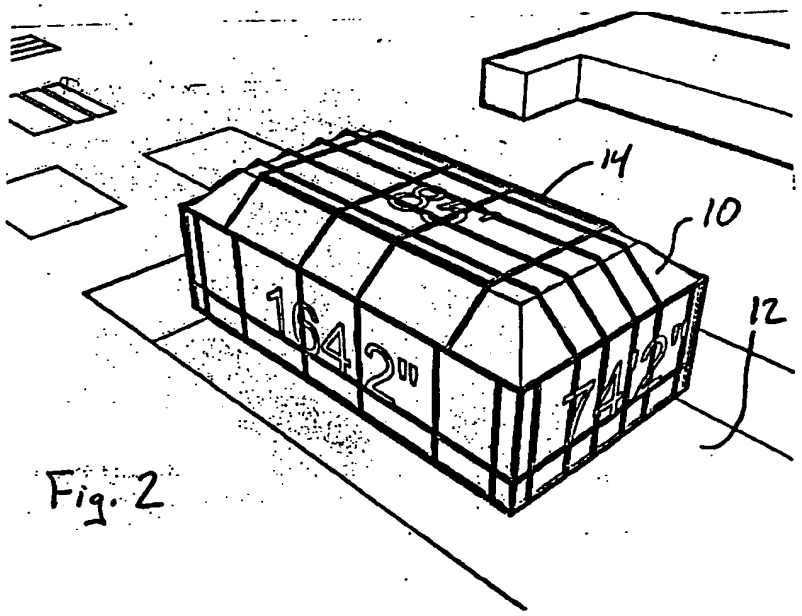
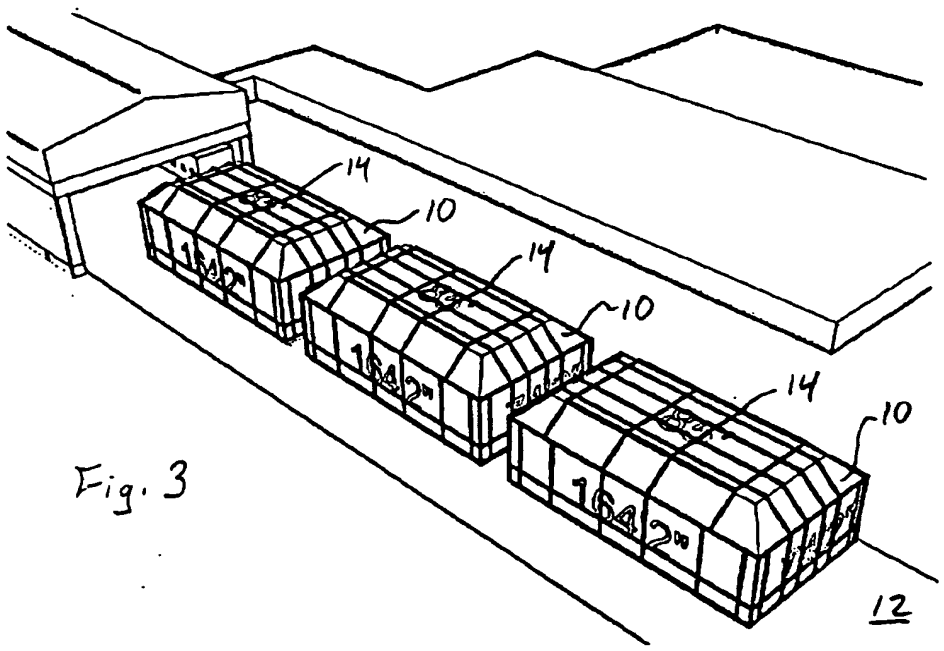


Fig. 2



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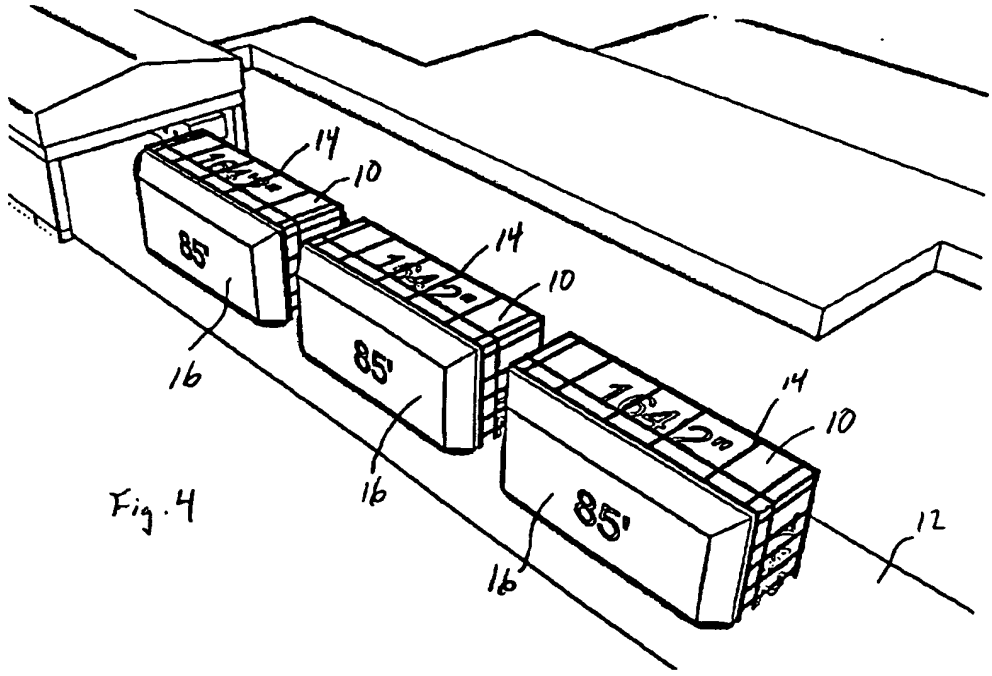


Fig. 4

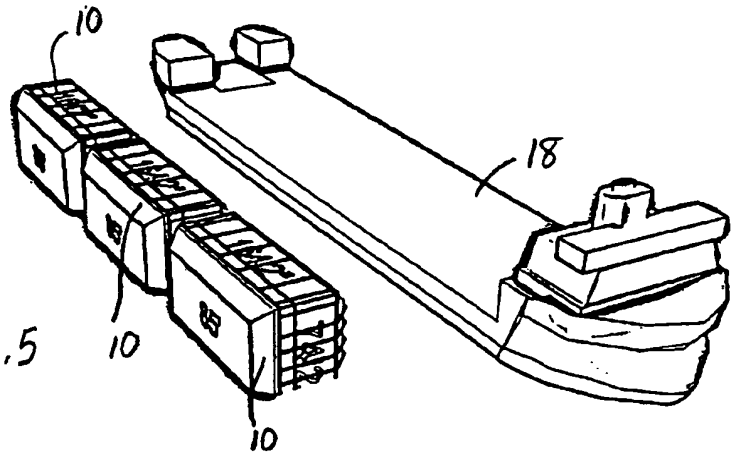


Fig. 5

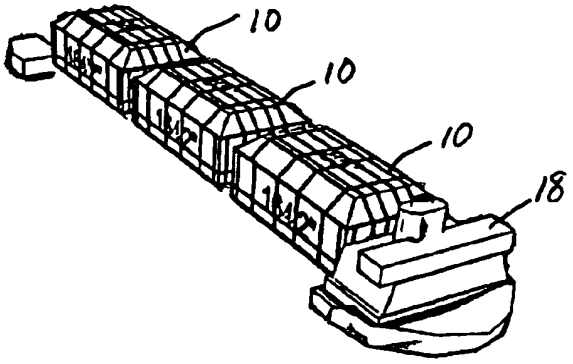
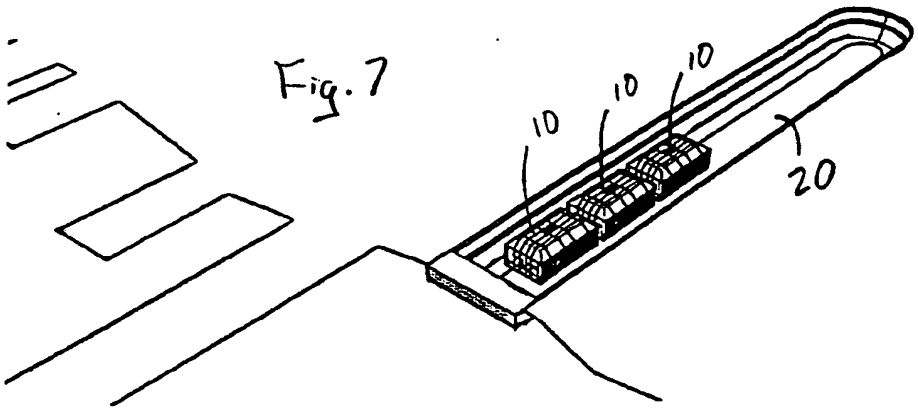
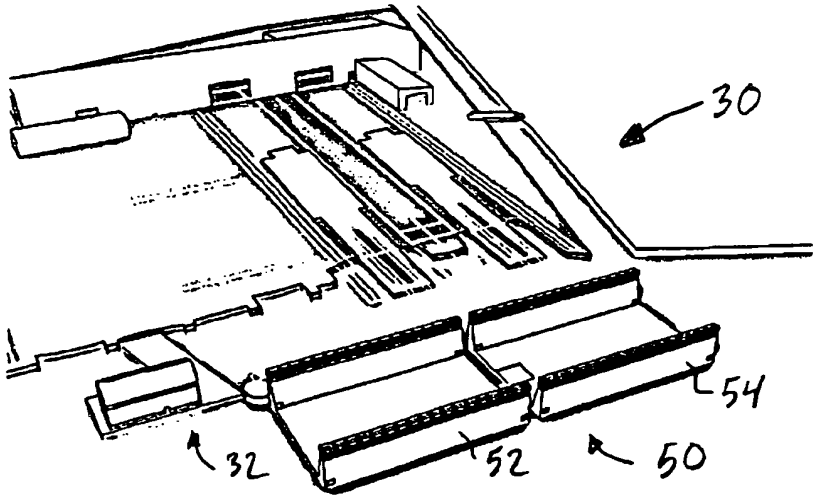


Fig. 6

Fig. 7





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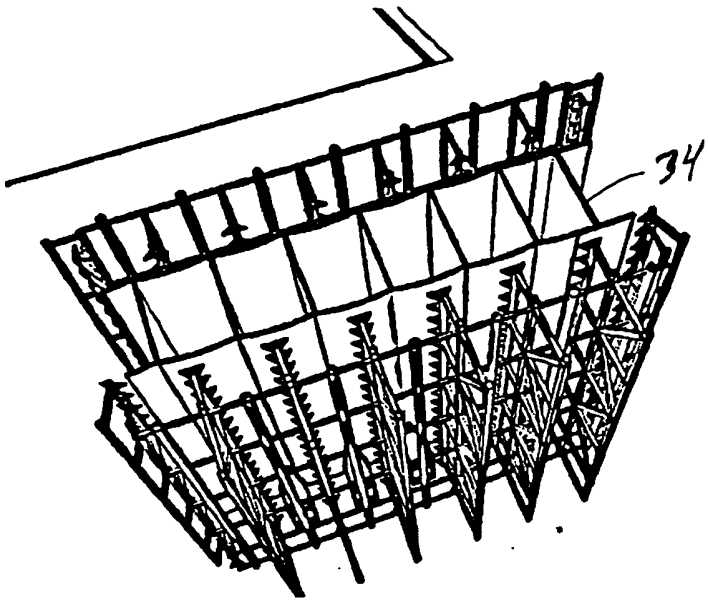

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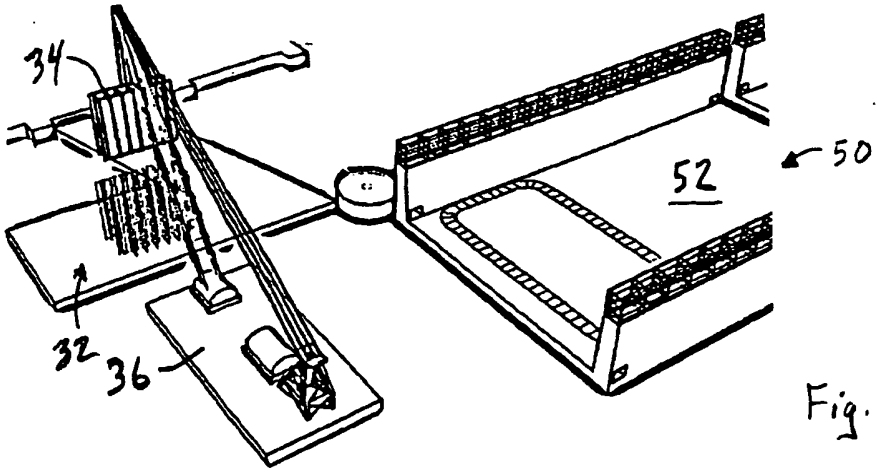

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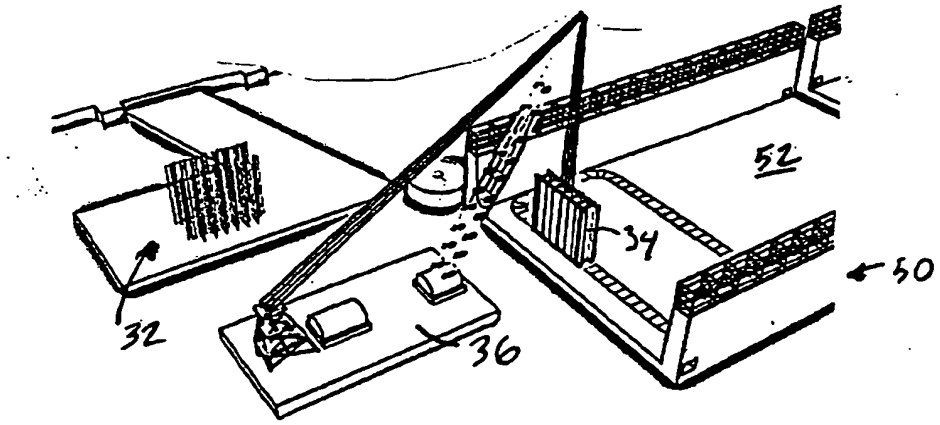

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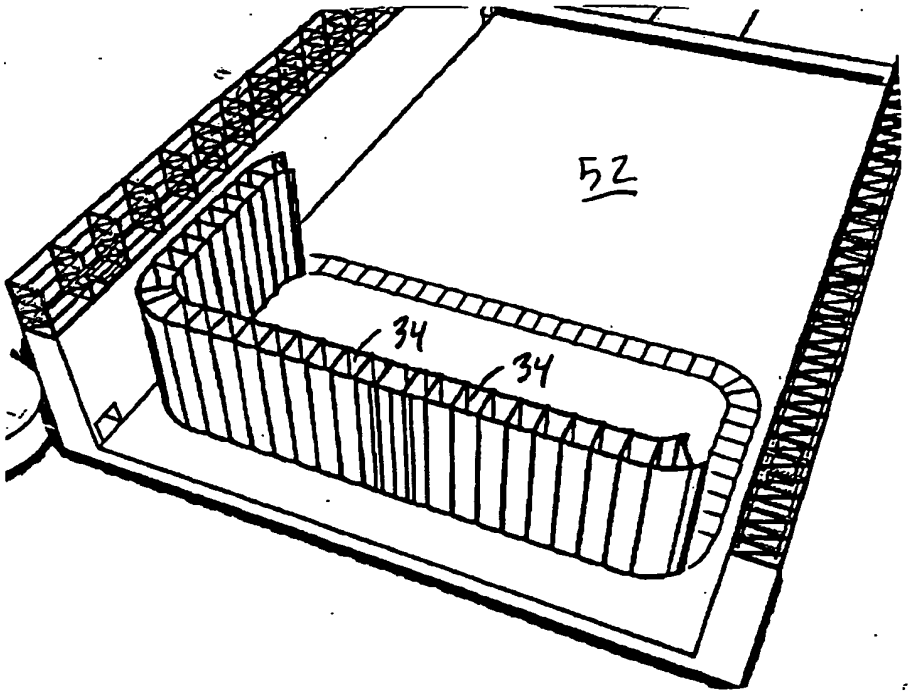

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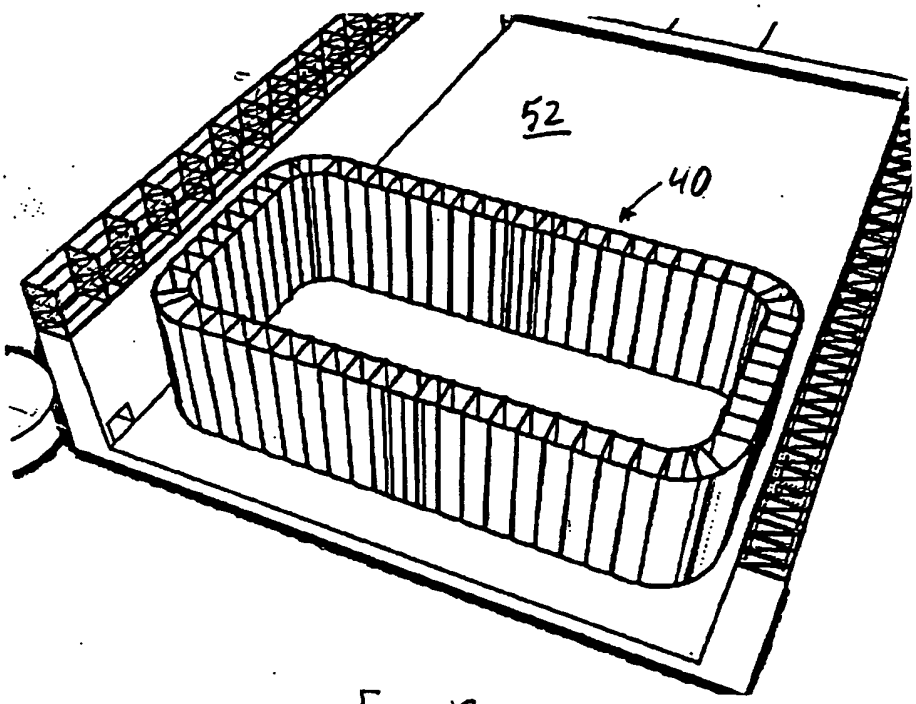

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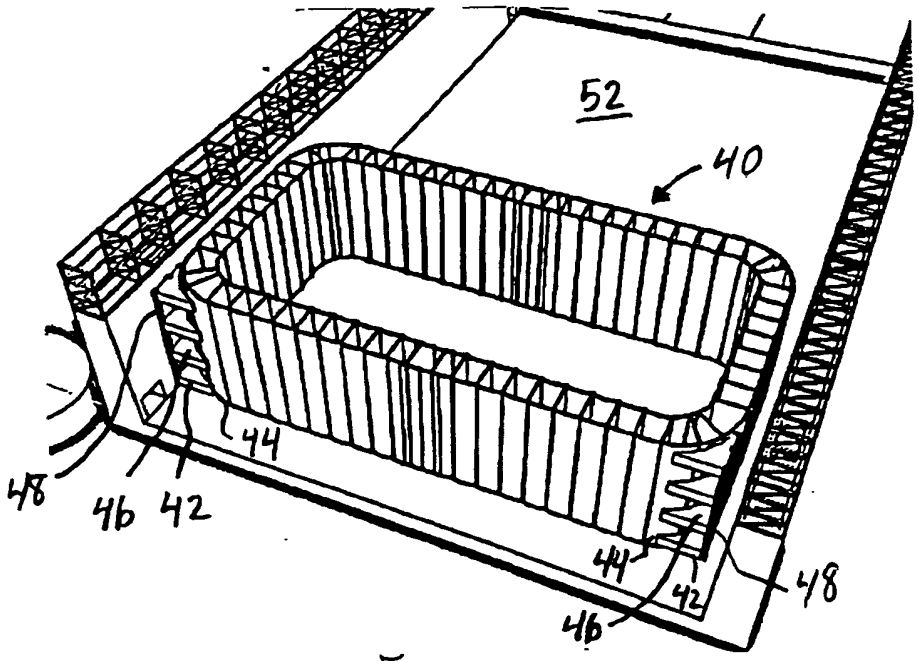

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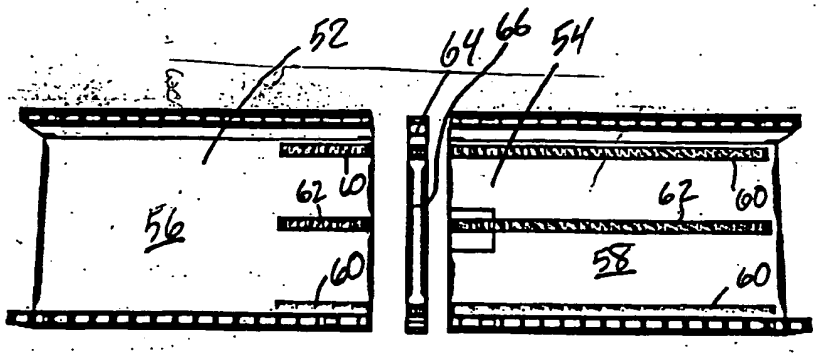

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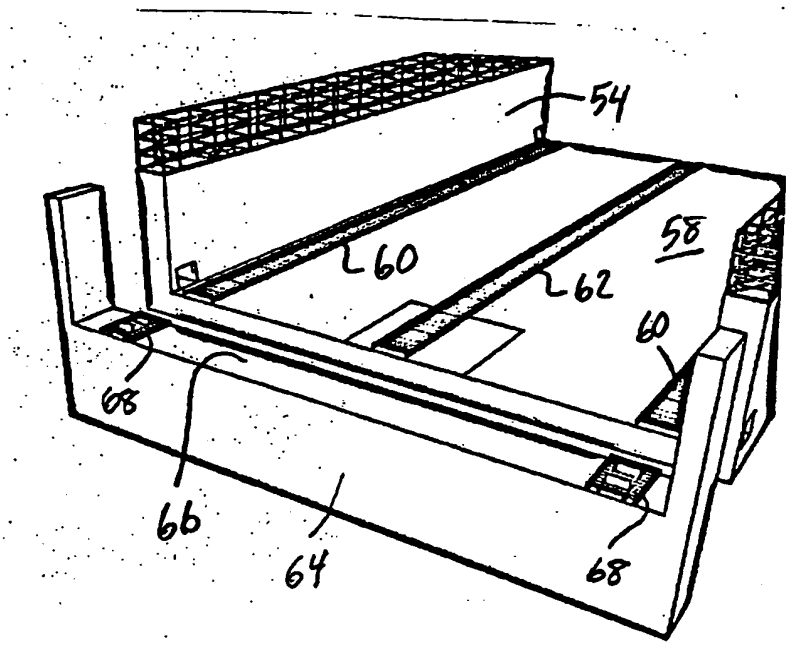

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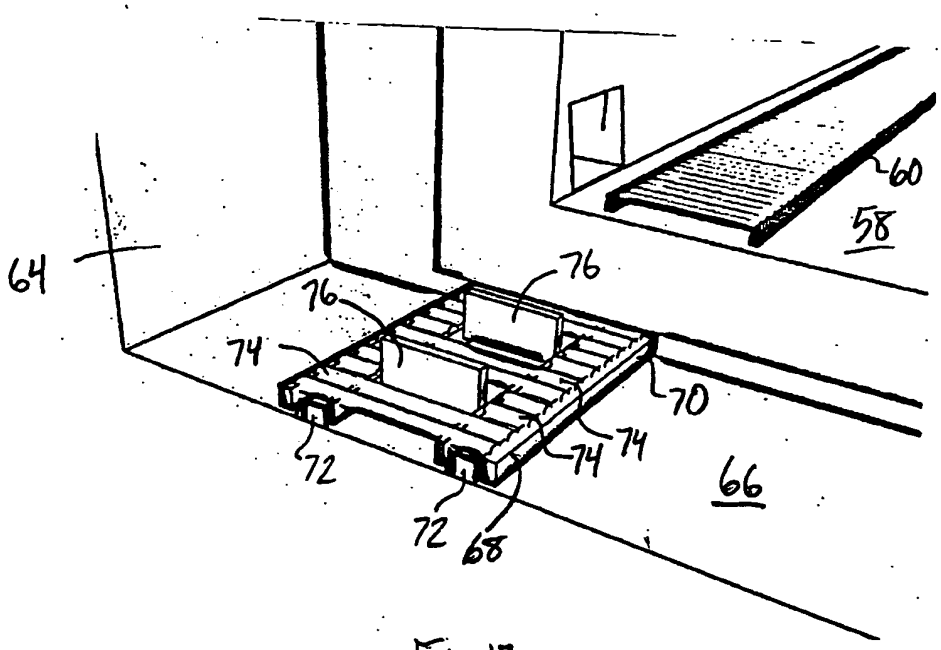
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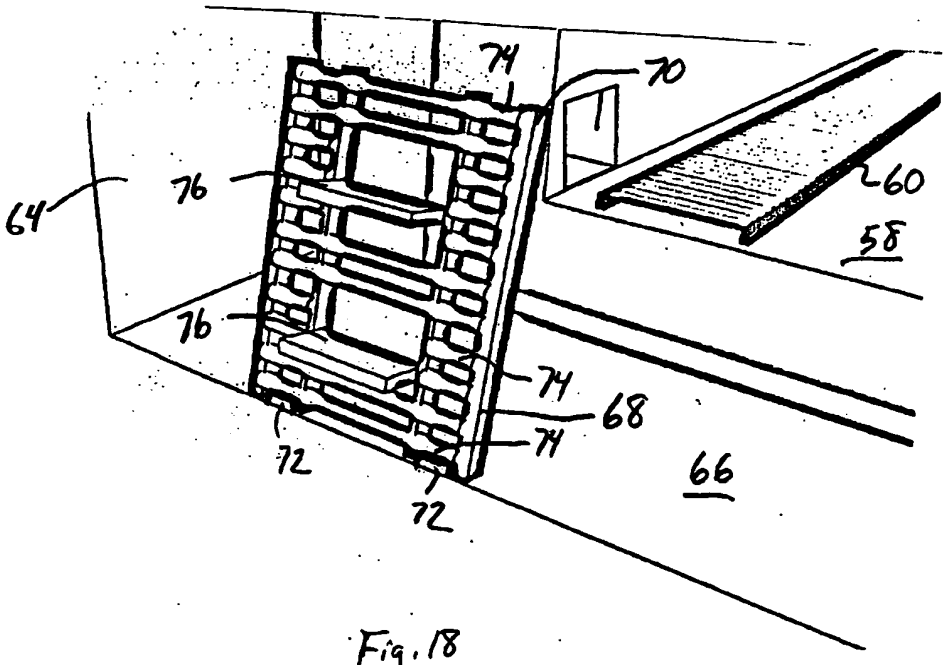
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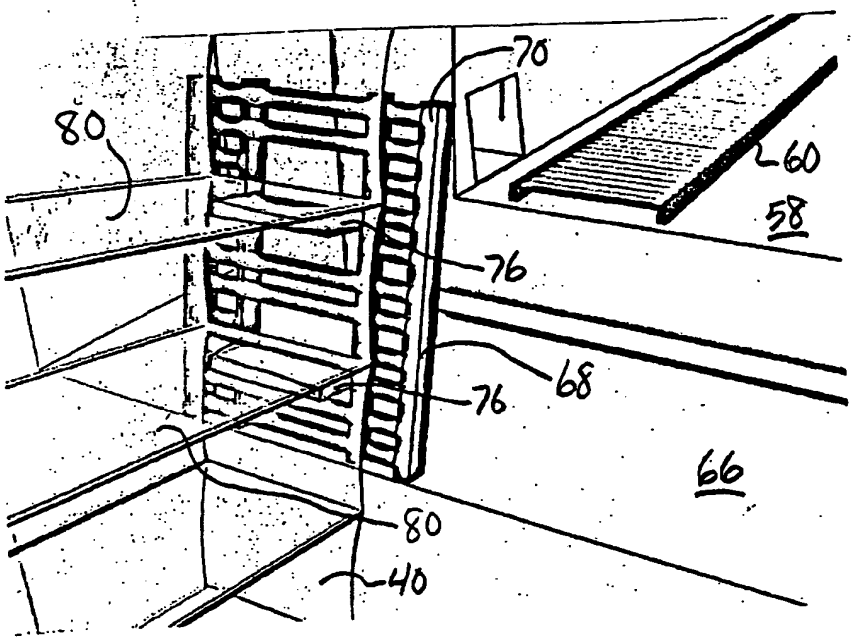
Fig. 18



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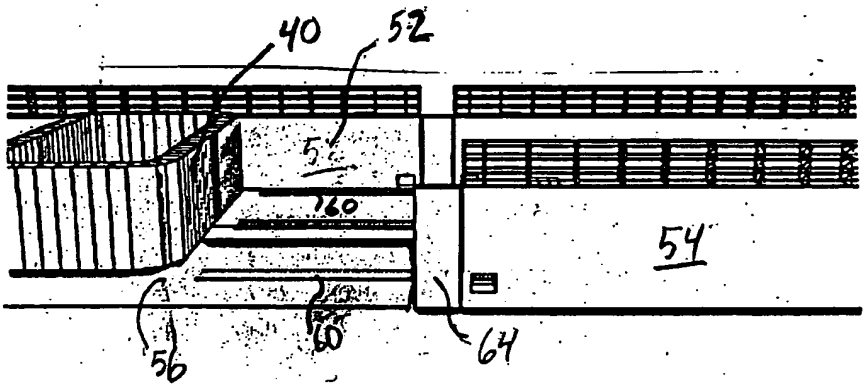

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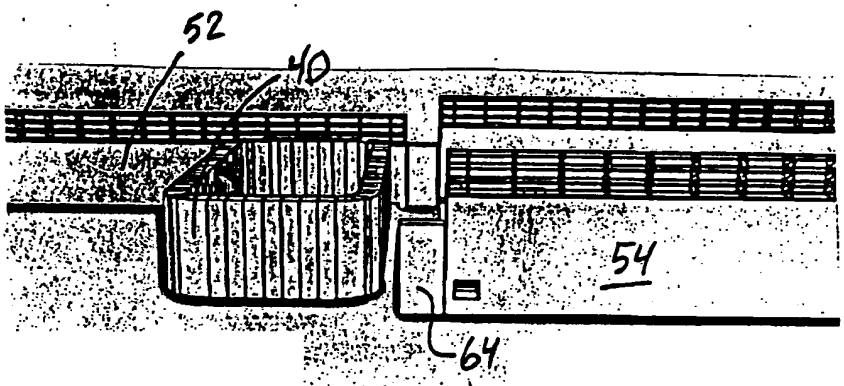

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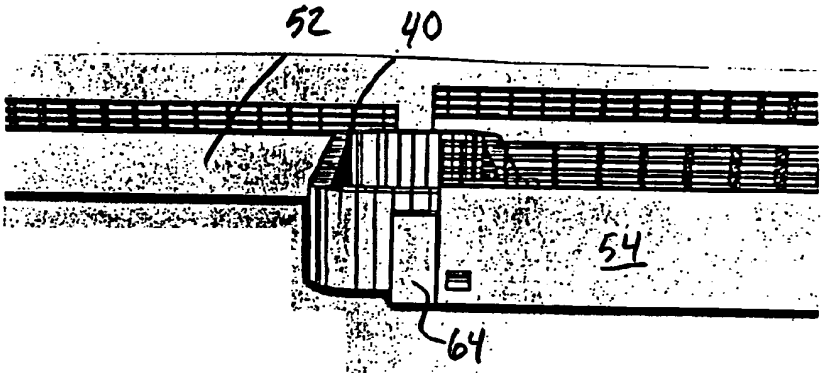

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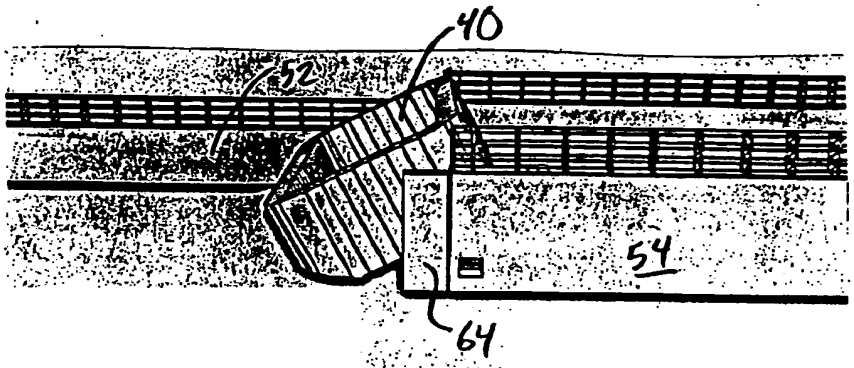
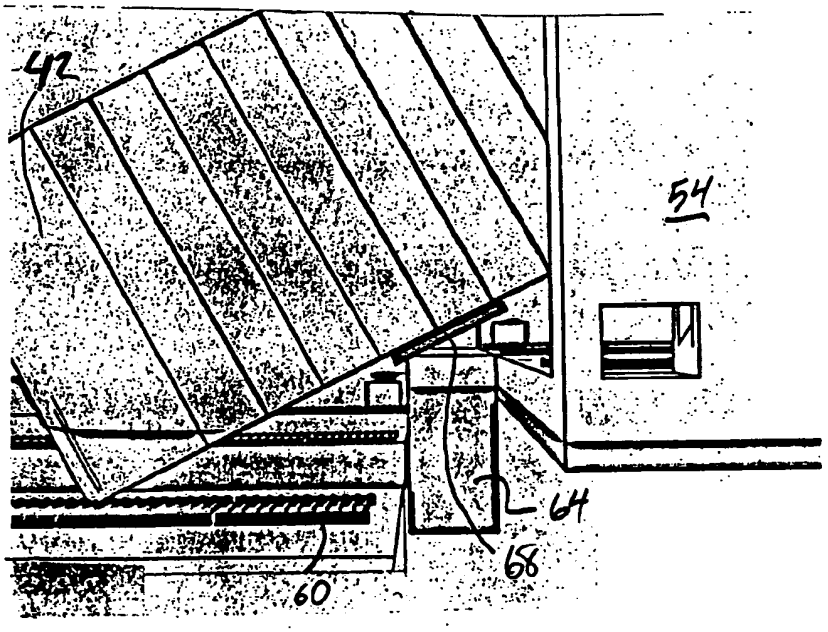


Fig. 23



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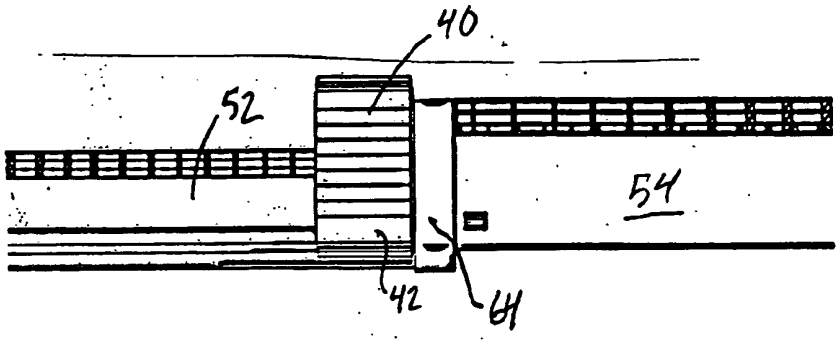

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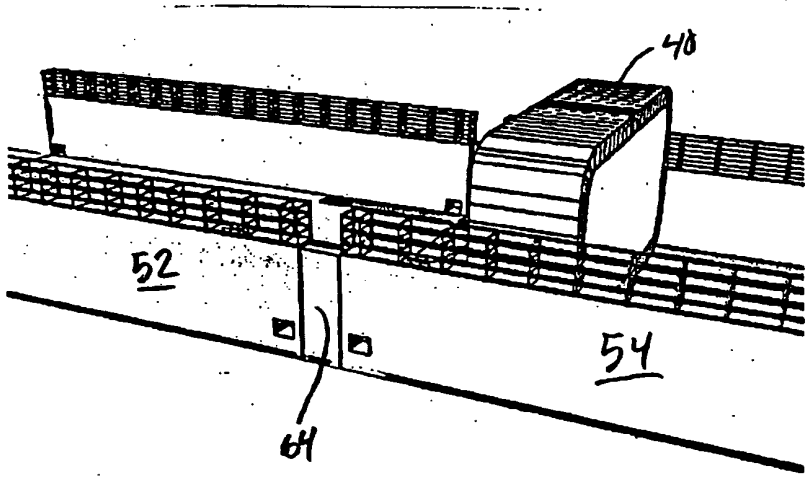

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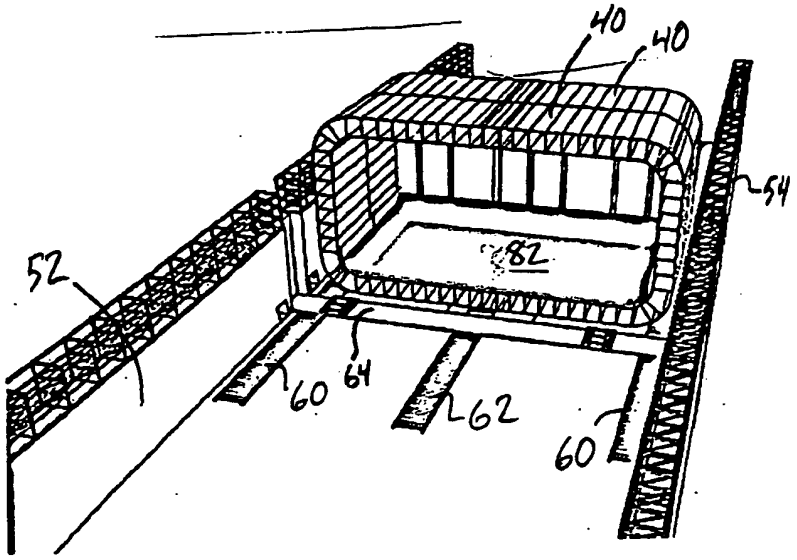

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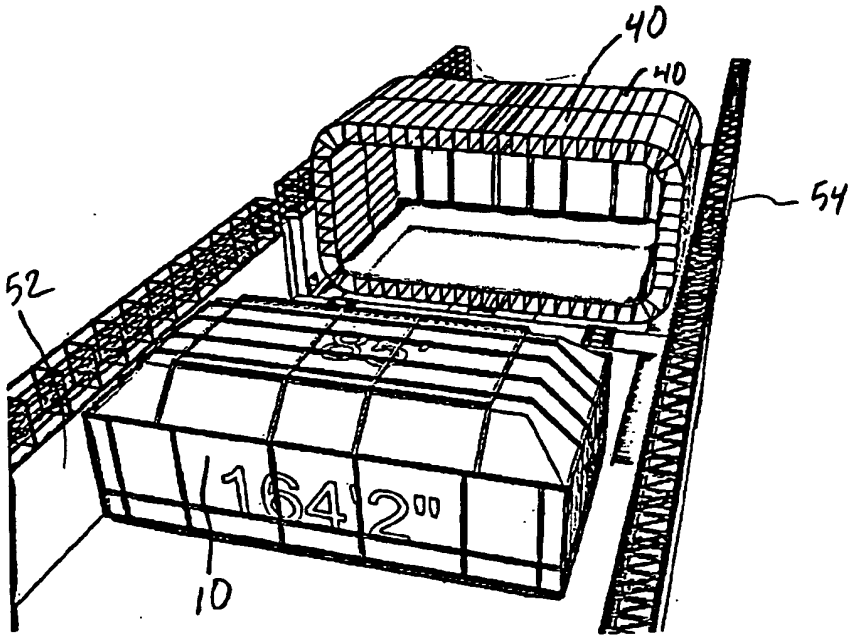

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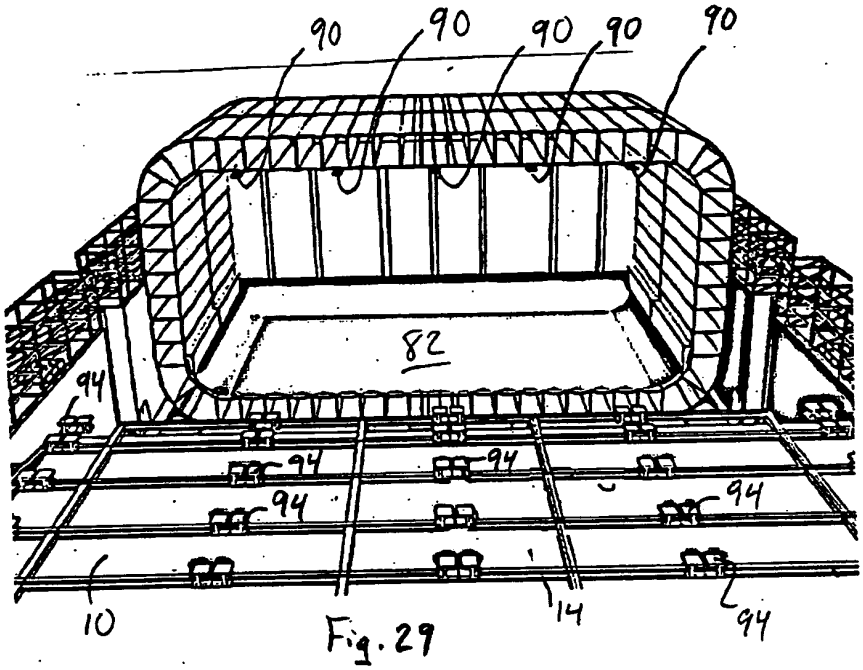

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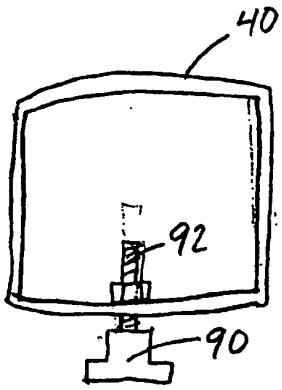

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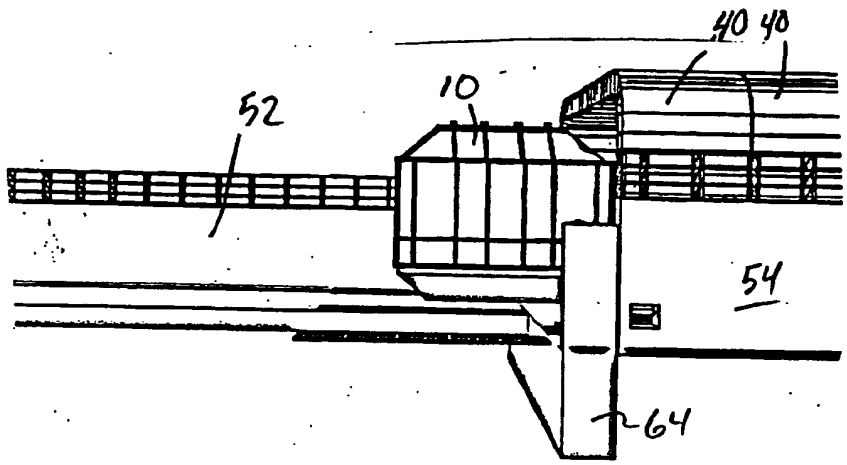

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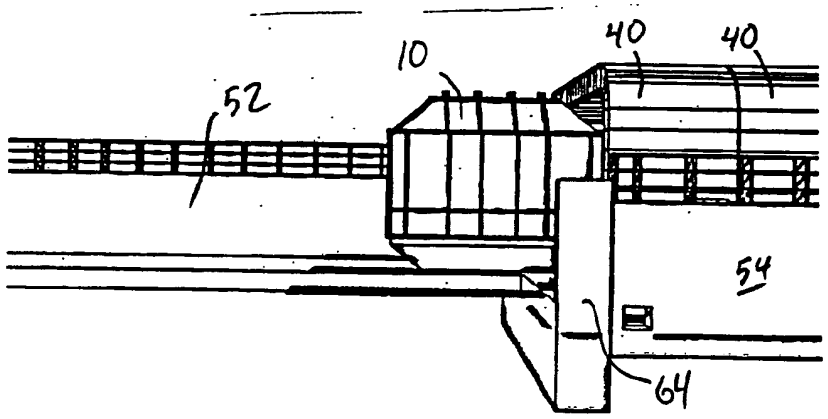

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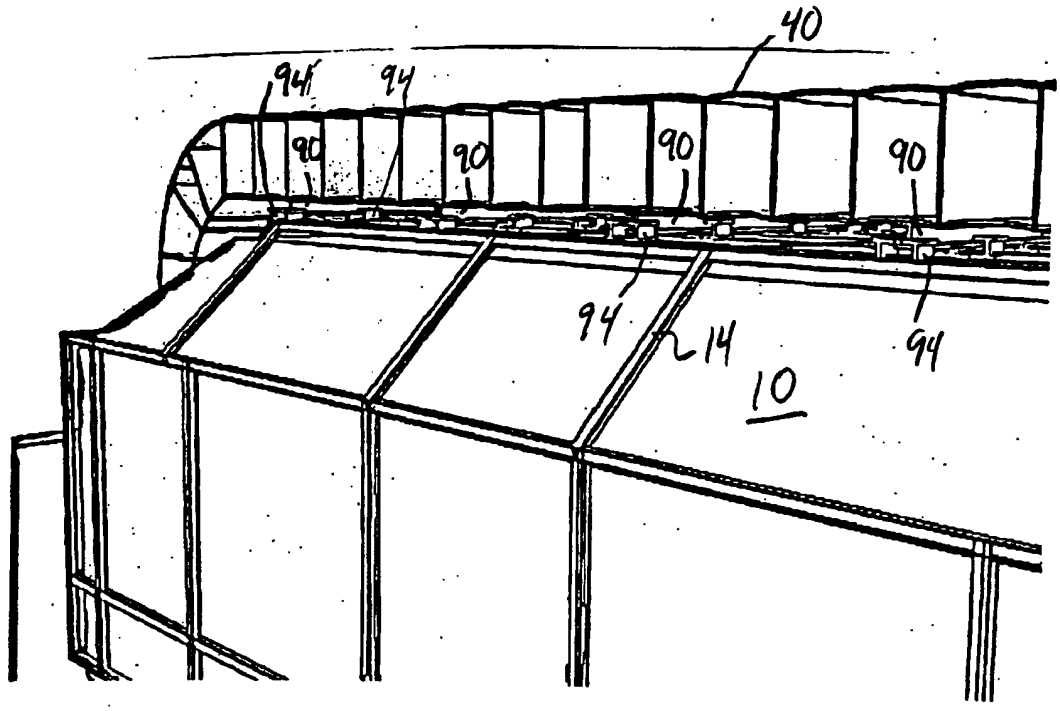

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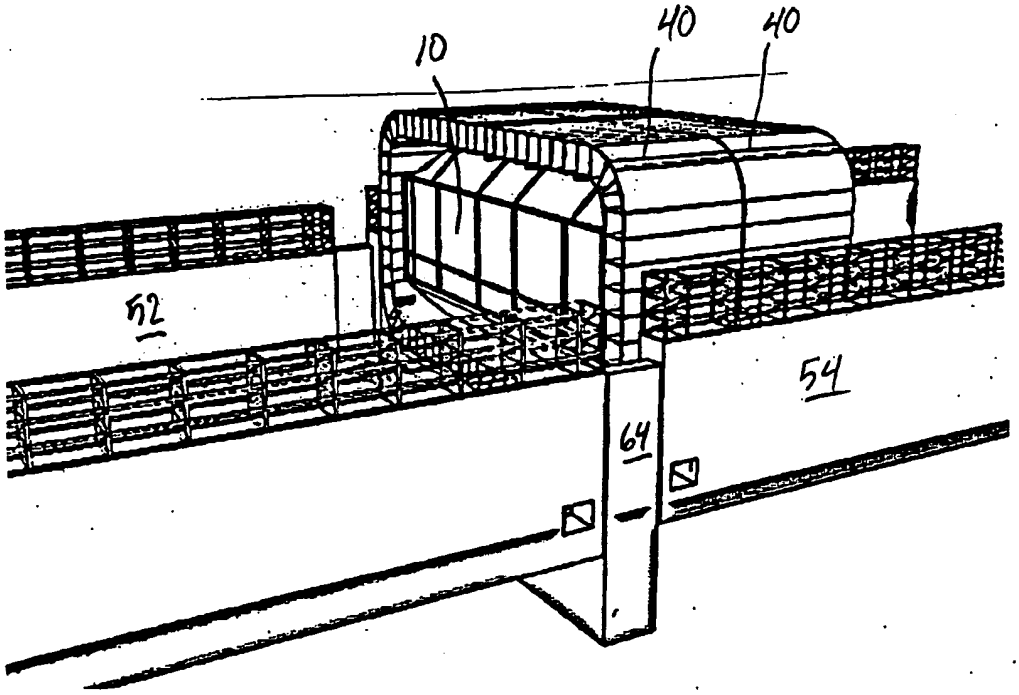

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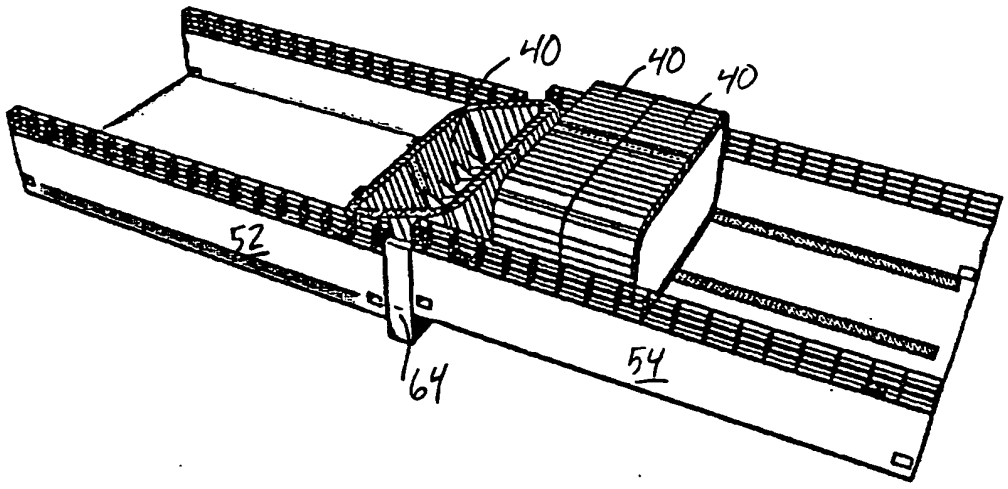

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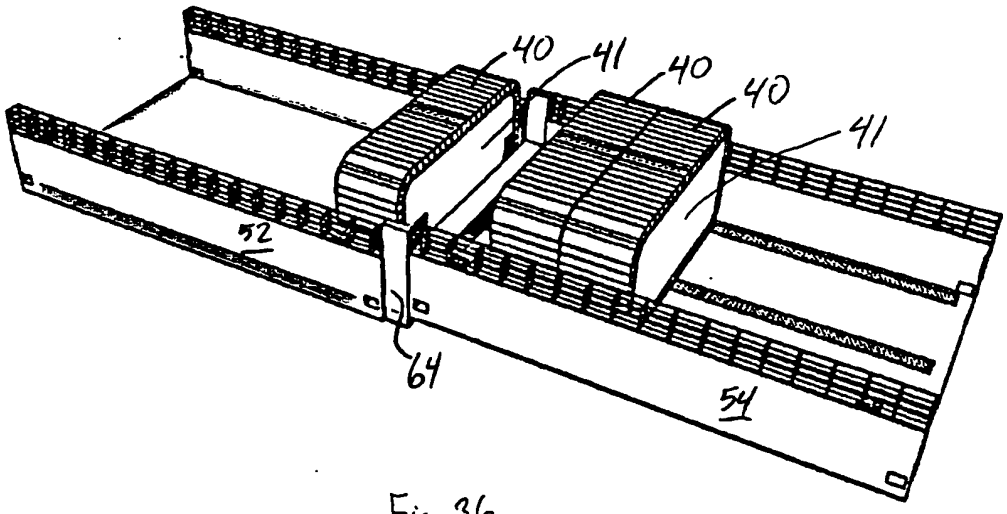

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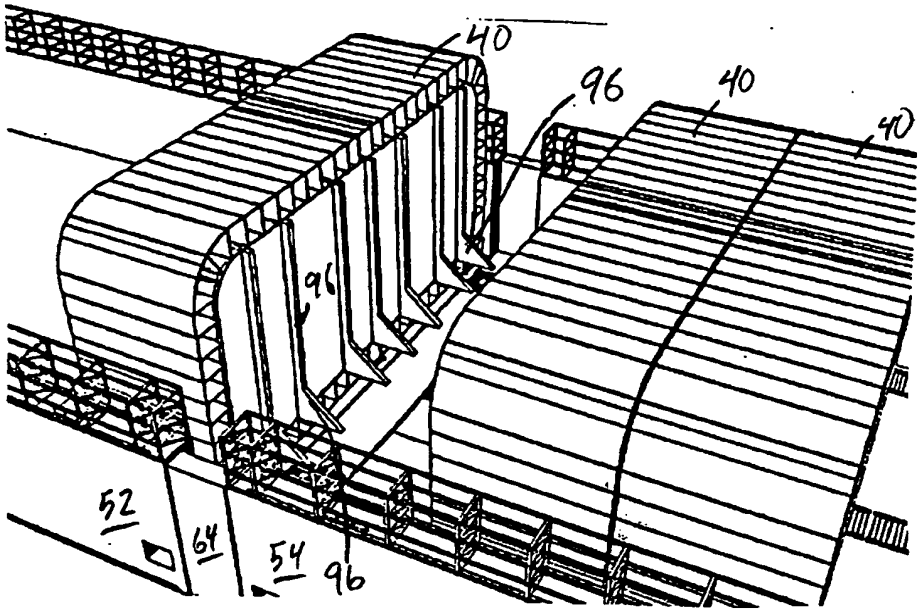

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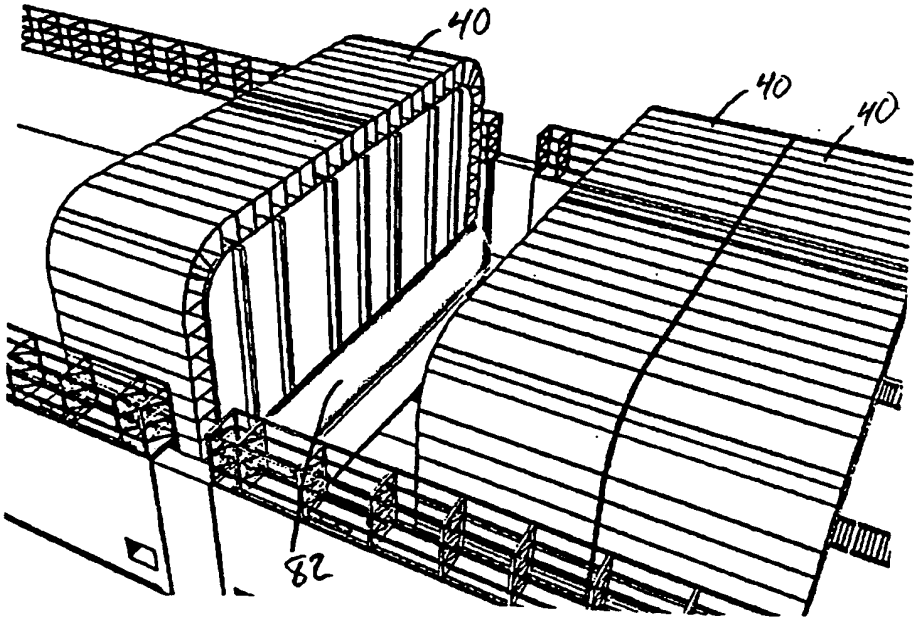

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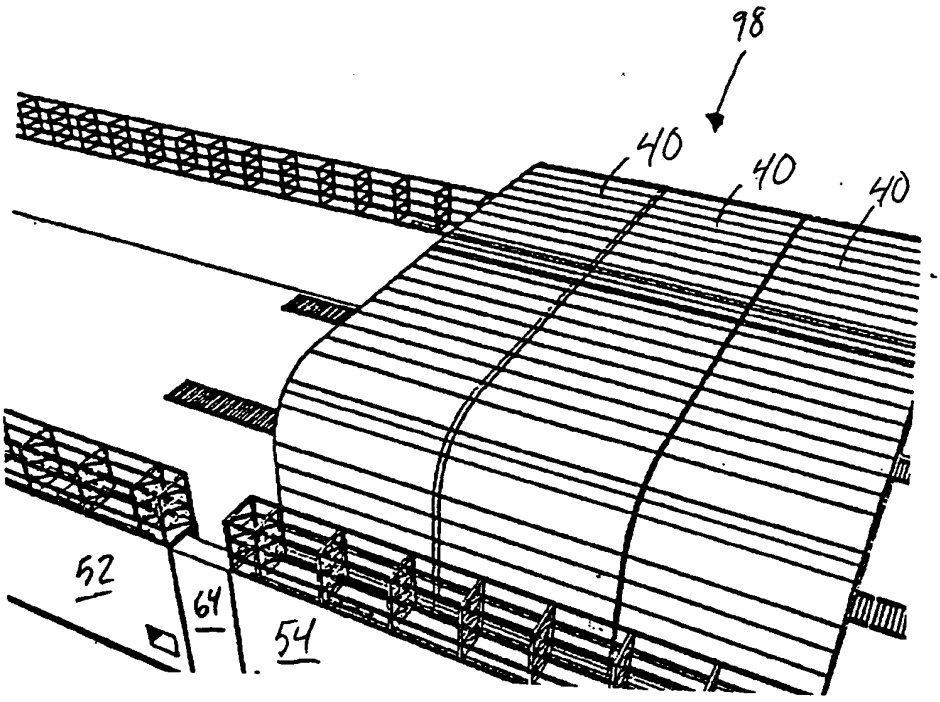

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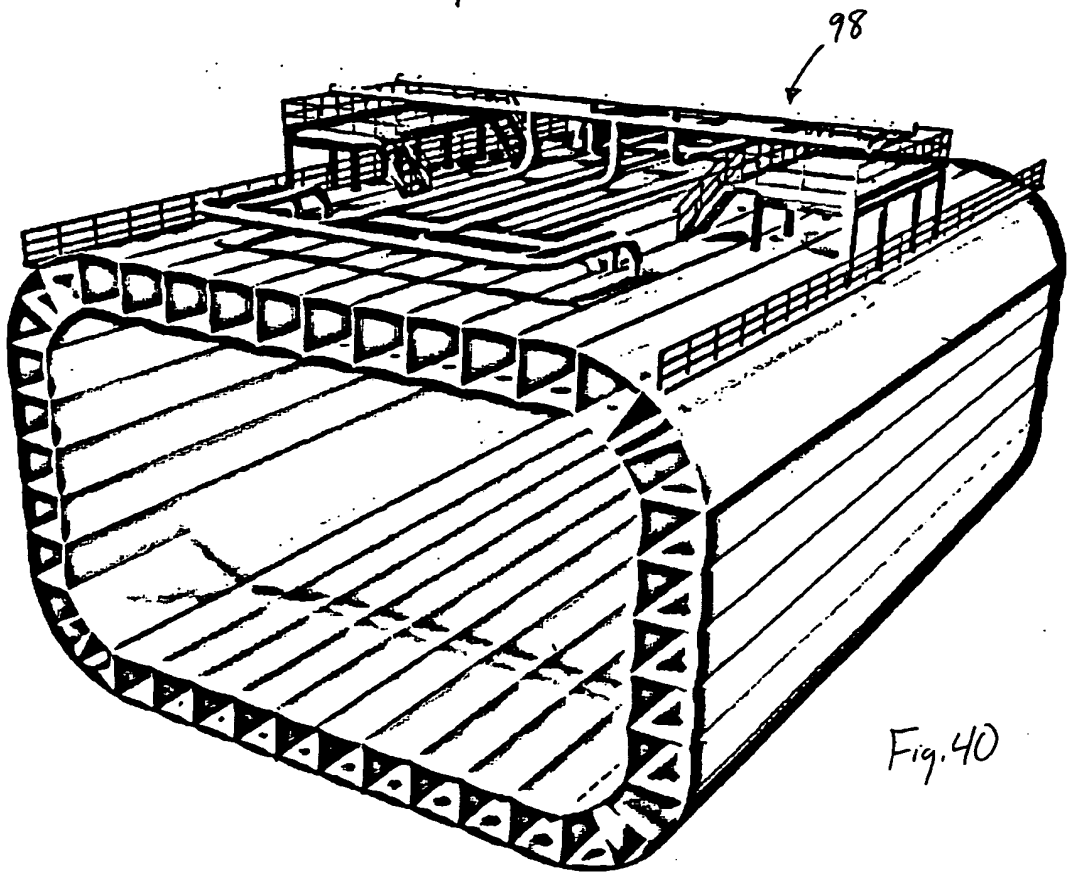

Fig. 40

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
17 October 2002 (17.10.2002)

PCT

(10) International Publication Number
WO 02/081297 A3

(51) International Patent Classification[7]: B63B 9/06, 3/04, 25/16

(21) International Application Number: PCT/US02/10173

(22) International Filing Date: 2 April 2002 (02.04.2002)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/280,745 3 April 2001 (03.04.2001) US

(71) Applicant *(for all designated States except US)*: **METRO MACHINE CORP.** [US/US]; 200 Ligon Street, Norfolk, VI 23523 (US).

(72) Inventor; and

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(74) Agent: **KLIMA, Timothy, J.**; The Law Offices of Timothy J. Klima, Suite 330, One Massachusetts Avenue NW, Washington, DC 20001 (US).

(81) Designated States *(national)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, MZ, NO, NZ, OM, PH, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZM, ZW.

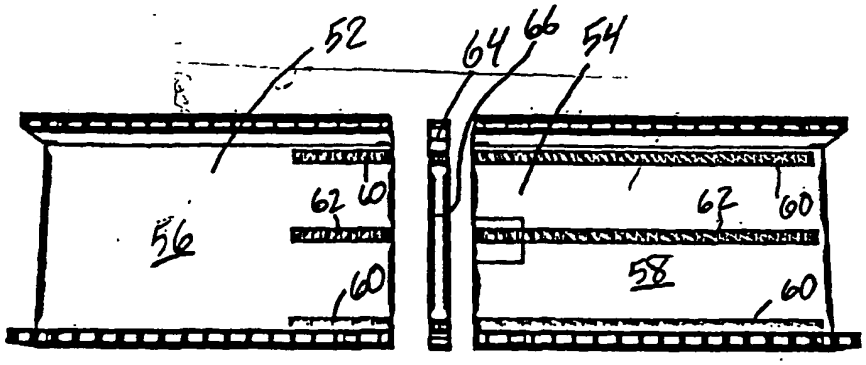
(84) Designated States *(regional)*: ARIPO patent (GH, GM, KE, LS, MW, MZ, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE, TR), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— *with international search report*
— *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

(88) Date of publication of the international search report:
28 November 2002

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: LNG STORAGE VESSEL AND METHOD FOR CONSTRUCTING SAME



(57) Abstract: A module assembly floating dry-dock includes a first pontoon (52), a module turning caisson (64) and a second pontoon (54) positioned adjacent each other, each capable of independent lowering and raising. Hull module subassemblies are lifted into position onto the first pontoon (52) and welded together to construct a hull module laying on its side. The first pontoon (52) can be lowered to float the hull module such that the hull module can straddle the module turning caisson (64). The module turning caisson is then raised to engage a tilting roller conveyor with the hull module, and the first pontoon further lowered, to turn the hull module into an upright position. The hull module can be moved over the roller tracks to an assembly position on the second pontoon (54). The process is then repeated to construct a second hull module and move it into an aligned position adjacent the first hull module so that the two hull modules can be welded together.

WO 02/081297 A3

INTERNATIONAL SEARCH REPORT

Internat[redacted] Application No
PCT/US 02/10173

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B63B9/06 B63B3/04 B63B25/16

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 B63B

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category °	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 5 269 246 A (GOLDBACH RICHARD A ET AL) 14 December 1993 (1993-12-14) cited in the application	1
A	figures 56-72	2-6
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1 October 2002	09/10/2002

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European Patent Office, P.B. 5818 Patentlaan 2 NL – 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	De Schepper, H

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